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Diet counts: Iron intake in teen years can impact brain in later life

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(Medical Xpress) -- Iron is a popular topic in health news. Doctors prescribe it for medical reasons, and it's available over the counter as a dietary supplement. And while it's known that too little iron can result in cognitive problems, it's also known that too much promotes neurodegenerative diseases.

Now, researchers at UCLA have found that in addition to causing cognitive problems, a lack of iron early in life can affect the brain's physical structure as well.

UCLA neurology professor Paul Thompson and his colleagues measured levels of transferrin, a protein that transports iron throughout the body and brain, in adolescents and discovered that these transferrin levels were related to detectable differences in both the brain's macro-structure and micro-structure when the adolescents reached young adulthood.

The researchers also identified a common set of genes that influences both transferrin levels and brain structure. The discovery may shed light on the neural mechanisms by which iron affects cognition, neurodevelopment and neurodegeneration, they said.

Their findings appear in the current online edition of the journal Proceedings of the National Academy of Sciences.

Iron and the proteins that transport it are critically important for brain function. Iron deficiency is the most common nutritional deficiency worldwide, causing poor cognitive achievement in school-aged children. Yet later in life, iron overload is associated with damage to the brain, and abnormally high iron concentrations have been found in the brains of patients with Alzheimer's, Parkinson's and Huntington diseases.

Since both a deficiency and an excess of iron can negatively impact brain function, the body's regulation of iron transport to the brain is crucial. When iron levels are low, the liver produces more transferrin for increased iron transport. The researchers wanted to know whether brain structure in healthy adults was also dependent on transferrin levels.

"We found that healthy brain wiring in adults depended on having good iron levels in your teenage years," said Thompson, a member of UCLA's Laboratory of Neuro Imaging. "This connection was a lot stronger than we expected, especially as we were looking at people who were young and healthy — none of them would be considered iron-deficient.

"We also found a connection with a gene that explains why this is so. The gene itself seems to affect brain wiring, which was a big surprise," he said.

To assess brain volume and integrity, Thompson's team collected brain MRI scans on 615 healthy young-adult twins and siblings, who had an average age of 23. Of these subjects, 574 were also scanned with a type of MRI called a "diffusion scan," which maps the brain's myelin connections and their strength, or integrity. Myelin is the fatty sheath that coats the brain's nerve axons, allowing for efficient conduction of nerve impulses, and iron plays a key role in myelin production.

Eight to 12 years before the current imaging study, researchers measured the subjects' blood transferrin levels. They hoped to determine whether iron availability in the developmentally crucial period of adolescence impacted the organization of the brain later in life.

"Adolescence is a period of high vulnerability to brain insults, and the brain is still very actively developing," Thompson said.

By averaging the subjects' transferrin levels, which had been assessed repeatedly — at 12, 14 and 16 years of age — the researchers estimated iron availability to the brain during adolescence, he said.

The team discovered that subjects who had elevated transferrin levels — a common sign of poor iron levels in a person's diet — had structural changes in brain regions that are vulnerable to neurodegeneration. And further analyses of the twins in the study revealed that a common set of genes influences both transferrin levels and brain structure.

One of the genetic links — a specific variation in a gene called HFE, which is known to influence blood transferrin levels — was associated with reduced brain-fiber integrity, although subjects carrying this gene variant did not yet show any symptoms of disease or cognitive impairment.

"So this is one of the deep secrets of the brain," Thompson said. "You wouldn't think the iron in our diet would affect the brain so much in our teen years. But it turns out that it matters very much. Because myelin speeds your brain's communications, and iron is vital for making myelin, poor iron levels in childhood erode your brain reserves which you need later in life to protect against aging and Alzheimer's.

"This is remarkable, as we were not studying iron deficient people, just around 600 normal healthy people. It underscores the need for a balanced diet in the teenage years, when your brain's command center is still actively maturing. "

The findings, he said, may aid future studies of how iron transport affects brain function, development and the risk of neurodegeneration.